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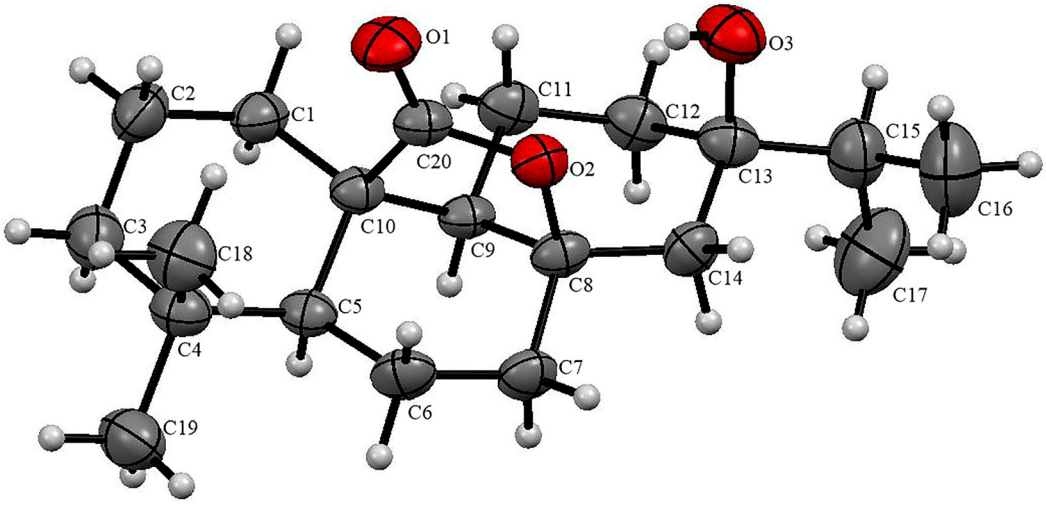
Synthesis and crystal structure of (4a*R*,7*S*)-7-hydroxy-7-isopropyl-1,1-dimethyldecahydro-2*H*,6*H*-8*a*,4*a*-(epoxymethano)phenanthren-12-one, $C_{20}H_{32}O_3$



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Abstract

$C_{20}H_{32}O_3$, monoclinic, $P2_1$ (no. 4), a = 7.8981(17) Å, b = 10.302(2) Å, c = 11.028(3) Å, β = 90.020(2)°, V = 897.3(3) Å^3, Z = 2, $R_{gt}(F)$ = 0.0603, $wR_{ref}(F^2)$ = 0.1342, T = 273(2) K.

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The molecular structure is shown in the figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

Table 1: Data collection and handling.

Crystal:	Colorless block
Size:	0.24 × 0.21 × 0.20 mm
Wavelength:	Mo *K*α radiation (0.71073 Å)
μ:	0.08 mm^{-1}
Diffractometer, scan mode:	Bruker APEX-II, φ and ω
θ_{max}, completeness:	31.0°, 99%
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	5323, 4825, 0.019
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\sigma(I_{obs})$, 2583
$N(param)_{refined}$:	213
Programs:	Olex2 [1], Bruker [2], SHELX [3], Diamond [4]

Source of material

Lophanic acid (100 mg, 0.3125 mmol), triphenylphosphine (PPh_3, 164 mg, 0.625 mmol), I_2 (40 mg, 0.1562 mmol), K_2CO_3 (86 mg, 0.625 mmol) were dissolved in methylene chloride (DCM, 2 mL). The resulting mixture was stirred at room temperature for 0.5 h until the starting materials were completely transformed. When the reaction was complete, checked by thin-layer chromatography (TLC) analysis, after termination by pure water (30 mL), the reaction was

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Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2).

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
O1	0.6734 (3)	0.2919 (2)	0.3986 (2)	0.0530 (7)
C1	0.3929 (4)	0.4837 (3)	0.4476 (3)	0.0411 (9)
H1A	0.380995	0.412992	0.504986	0.049*
H1AB	0.333720	0.558234	0.480651	0.049*
C2	0.3081 (5)	0.4447 (4)	0.3289 (3)	0.0510 (9)
H2A	0.356020	0.363558	0.300538	0.061*
H2AB	0.188054	0.431422	0.342639	0.061*
O2	0.8512 (3)	0.4320 (2)	0.4890 (2)	0.0384 (6)
O3	0.9047 (4)	0.3847 (2)	0.7534 (2)	0.0559 (7)
H3	0.882811	0.361071	0.684114	0.084*
C3	0.3325 (5)	0.5482 (4)	0.2333 (4)	0.0515 (10)
H3A	0.280874	0.628338	0.261039	0.062*
H3AB	0.274820	0.521785	0.159642	0.062*
C4	0.5202 (5)	0.5734 (4)	0.2045 (3)	0.0441 (9)
C6	0.8089 (4)	0.6237 (4)	0.3073 (3)	0.0449 (9)
H6A	0.855041	0.544152	0.273758	0.054*
H6AB	0.829594	0.692786	0.249438	0.054*
C5	0.6175 (4)	0.6076 (3)	0.3242 (3)	0.0355 (8)
H5	0.576065	0.693593	0.347961	0.043*
C8	0.8441 (4)	0.5697 (3)	0.5310 (3)	0.0351 (8)
C7	0.9012 (4)	0.6552 (4)	0.4258 (3)	0.0417 (9)
H7A	1.021935	0.643993	0.413791	0.050*
H7AB	0.881165	0.745389	0.446456	0.050*
C9	0.6529 (4)	0.5857 (3)	0.5513 (3)	0.0338 (7)
H9	0.622414	0.677940	0.551002	0.041*
C10	0.5819 (4)	0.5177 (3)	0.4360 (3)	0.0336 (7)
C11	0.5965 (4)	0.5222 (4)	0.6700 (3)	0.0420 (9)
H11A	0.480102	0.546565	0.686523	0.050*
H11B	0.600275	0.428615	0.660794	0.050*
C12	0.7069 (4)	0.5615 (4)	0.7772 (3)	0.0440 (9)
H12A	0.664368	0.519595	0.849889	0.053*
H12B	0.698090	0.654564	0.788960	0.053*
C13	0.8931 (4)	0.5255 (3)	0.7605 (3)	0.0412 (8)
C14	0.9573 (4)	0.5852 (3)	0.6417 (3)	0.0416 (8)
H14A	0.975277	0.677280	0.655101	0.050*
H14B	1.066516	0.547096	0.623234	0.050*
C15	1.0019 (5)	0.5633 (4)	0.8717 (3)	0.0563 (10)
H15	0.958460	0.513253	0.940575	0.068*
C16	1.1877 (5)	0.5248 (6)	0.8562 (5)	0.0846 (17)
H16A	1.194572	0.435086	0.833299	0.127*
H16B	1.246856	0.537841	0.931250	0.127*
H16C	1.238324	0.577467	0.794132	0.127*
C17	0.9914 (6)	0.7060 (5)	0.9077 (5)	0.0847 (16)
H17A	1.033624	0.758815	0.842748	0.127*
H17B	1.058302	0.720423	0.979171	0.127*
H17C	0.875658	0.728469	0.923976	0.127*
C18	0.5942 (5)	0.4546 (4)	0.1382 (4)	0.0594 (11)
H18A	0.527554	0.436426	0.067410	0.089*
H18B	0.592320	0.380856	0.191370	0.089*
H18C	0.708762	0.472645	0.114584	0.089*
C19	0.5287 (5)	0.6915 (4)	0.1180 (4)	0.0611 (12)
H19A	0.644044	0.706320	0.094445	0.092*
H19B	0.485736	0.766999	0.158745	0.092*
H19C	0.461467	0.674460	0.047236	0.092*
C20	0.6995 (4)	0.4006 (3)	0.4358 (3)	0.0361 (8)

extracted with methylene chloride (3*90 mL). The combined organic phase was dried over anhydrous Na_2SO_4, filtered, concentrated under reduced pressure, and purified by silica gel column chromatography eluting with petroleum ether/ethyl acetate (10:1) to afford compound (4a*R*,7*S*)-7-hydroxy-7-isopropyl-1,1-dimethyldecahydro-2*H*,6*H*-8*a*,4*a*-(epoxymethano) phenanthren-12-one in 85% yield. And the obtained solid was recrystallized with methanol to obtain the colorless needle crystal.

Experimental details

Comment

Lophanic acid is an abietane diterpenoid compound widely seen in medicinal plants *I. flavidus* [5] and *I. lophanthoides* [6]. Studies have revealed that this type of compound has significant antibacterial, anti-inflammatory, antitumor, anti-cancer, and other activities [7–12]. The research group started from medicinal plants *I. flavidus* isolated rich in lophanic acid. Nevertheless, the structural modification of the active functional groups and targets of lophanic acid has not been reported in the relevant literature. Hence, to investigate the active site of lophanic acid and synthesize a highly active derivative, we used lophanic acid as a raw material. Under the action of triphenylphosphine/iodine/potassium carbonate, the C8–C9 double bond of corinoic acid was oxidized to a hydroxyl group, where the C-8 hydroxyl group formed a lactone with C-20 carboxylic acid. Finally, the target compound is obtained. The title compound (4a*R*,7*S*)-7-hydroxy-7-isopropyl-1,1-dimethyldecahydro-2*H*,6*H*-8*a*,4*a*-(epoxymethano) phenanthren-12-one was obtained by Lophanic acid oxidation, esterification reaction.

The title compound is shown in the figure. The bond lengths and angles which were derived from the title structure are within normal ranges. In the molecule, the carbonyl group was confirmed by the distance *d*(C20–O1) = 1.210(4) Å. The compound contains three six membered carbon-based rings, one hydroxyl, five methyl and one carbonyl.

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Conflict of interest statement: The authors declare no conflicts of interest regarding this article.

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